Journal of Scientific Exploration, Vol. 22, No. 3, pp. 335–358, 2008 0892-3310/08

RESEARCH

New Insights into the Links between ESP and Geomagnetic Activity

Adrian Ryan

11 Heron Road, Twickenham TW1 1PQ, England
e-mail: adrian.ryan@greyheron1.plus.com

Abstract—A database of 343 free-response ESP trials conducted at centers in the U.K. was constructed in order to test the hypothesis that the relatively fast varying components of geomagnetic activity, *geomagnetic pulsations*, might be driving the reported associations between ESP, geomagnetic activity and local sidereal time. Local geomagnetic field measurements taken at 1-second intervals during 99 trials, and at 5-second intervals during 244 trials, were converted by fast Fourier transform into power within five frequency bands. Two patterns were observed: ESP was found to succeed only during periods of enhanced pulsation activity within the 0.2–0.5 Hz band, but ESP effect was absent during the most disturbed periods of activity in the 0.025–0.1 Hz band.

The pattern of ESP effect by local sidereal time was similar to that found by Spottiswoode (1997b), and this shape was found to be attributable to the pattern of ESP results by pulsation activity in the 0.2–0.5 Hz band.

The observed patterns were demonstrated to have excellent explanatory power in terms of accounting for findings previously reported in the literature.

Keywords: ESP—geomagnetic activity—geomagnetic pulsations—local sidereal time

Introduction

The investigation of apparent associations between extrasensory perception (ESP), geomagnetic activity (GMA) and local sidereal time (LST; a time system based on the rotation of the Earth with respect to star positions) is one of the most promising areas of research in parapsychology. If the parameters of these associations could be reliably defined, this information would allow experiments to be timed to maximize effects, would advance theory development, and might even lead to the development of technologies to enhance ESP. This paper presents the idea that a component of GMA, *geomagnetic pulsations*, may be driving both the GMA and LST associations that have been reported. This idea is then tested by comparing measurements of geomagnetic pulsations with the results of ESP experiments conducted at three centers within the U.K.: the University of Edinburgh, the University of Northampton and the Museum of Psychic Experience in York.

The Link between ESP and GMA

GMA is the aggregate of disturbances in the natural magnetic field surrounding the Earth caused by the interaction of that field with plasma (electrically charged gas) ejected from the Sun during solar storms. Researchers have often reported an association between the degree of GMA and the results of ESP experiments. These studies have generally used a crude global index of GMA, *ap*, which is derived from the difference between the lowest and highest field measurements during a 3-hour period from each of 13 observatories around the globe. This index therefore gives only very limited information about the degree and character of field disturbances at the location of the ESP experiment.

Most often, a negative correlation between ESP effect size and GMA is reported; that is to say, a stronger ESP effect is observed when the geomagnetic field is relatively undisturbed (Krippner & Persinger, 1996; Makarec & Persinger, 1987; Persinger & Krippner, 1989; Spottiswoode, 1990). In an analysis of two ganzfeld studies, however, Radin (1994) found opposing results: the first study showed no overall ESP effect, but a negative correlation with GMA, whereas the second found a significant ESP effect and a positive correlation with GMA. In ESP experiments during which complex, fluctuating magnetic fields were generated near participants, both Persinger et al. (2002) and Booth et al. (2002) found a positive correlation between ESP and GMA.

Some large studies with strong evidence of ESP show no correlation with GMA. For instance, Nelson and Dunne (1986) examined 334 precognitive remote viewing sessions and Persinger (1989) reported on 139 ganzfeld sessions conducted by Charles Honorton; both found no relationship between ESP and GMA. In a meta-analysis of 51 studies comprising 2,879 free-response trials, Spottiswoode (1997b) found, overall, a slight negative correlation of ESP with GMA ($r_s = -0.03$). Many papers have also suggested a link between spontaneous ESP experiences and GMA (Persinger, 1989), but interpretation of these is difficult as many have used inappropriate statistical methods (Wilkinson & Gauld, 1993).

These inconsistent findings may indicate that there is a mid-range of GMA that has a positive or negative influence on ESP, or alternatively there might be a complex interaction involving several geomagnetic components, each acting upon ESP in a different way.

The Link between ESP and LST

LST is time measured relative to the stars. Therefore, a given star will always pass overhead at an observer's location at the same LST. As the Earth is in orbit around the Sun, the relationship between solar time and sidereal time cycles through the year. Spottiswoode (1997a,b) checked for a relationship between ESP results and LST. He assembled 2,879 ESP trials into a database and graphed the ESP effect size by LST. Contrary to his expectation of a uniform distribution, he found that ESP effect size peaked at about 13:20 LST and fell close to zero at about 18:10 LST. One would reason that this could not be due to the influence of a factor that varies by time of day or time of year, because through the year, such a variation would be spread evenly across LST. However, as the large majority of ESP experiments in Spottiswoode's database were carried out in daylight hours, an influencing factor with seasonal variation *would* generate a systematic variation of ESP effect by LST. The trials in Spottiswoode's database do indeed exhibit a seasonal variation of ESP effect (Sturrock & Spottiswoode, 2007), so this will, at least partly, explain the shape of the LST graph.

Another class of influencing factor that would generate a non-uniform LST distribution is a factor that possesses a time of day variation which itself changes over the year, for example, a factor whose daily maximum shifts in local time through the year.

Geomagnetic pulsations meet these criteria. These regular fluctuations in the geomagnetic field are classified according to frequency (i.e., wavelength) and character (regular sinusoidal or irregular) (Campbell, 2003: 168; Jacobs, 1970), and each type exhibits distinct seasonal and/or interacting seasonal/daily variation (Jacobs, 1970).

Spottiswoode (1997b) went on to report that the overall slightly negative correlation of ESP with the global index of GMA was much stronger in a 2-hour window centered at about 12:55 LST, close to the LST of maximum effect size. Therefore, we need to identify factors not only whose occurrence varies by season, or have time of day variation that varies by season, but also that are closely related to GMA. Clearly, geomagnetic pulsations also meet this second criterion; the occurrence profile of each pulsation type has a distinct relationship to the global index (Jacobs, 1970). These fluctuations are therefore an excellent candidate for explaining both the GMA and LST associations with ESP.

Adams (1986) first suggested that geomagnetic pulsations might be linked to ESP success, but at that time, the detailed field measurements that would have allowed the hypothesis to be tested were not available. Now that suitable measurements are available, this paper is able to address the question directly for the first time.

ESP Trials

A database of free-response ESP trials was constructed, comprising trials for which local, high time-resolution measurements of the geomagnetic field were available. To reduce noise in the analysis a further criterion was applied: considering each condition within each study, only conditions with an ESP

TABLE 1
ESP Trials Used in the Analysis

Type	Where conducted	Study	Conditions	N	*es*	r_s (*ap, es*)
Ganzfeld	Edinburgh	Sender – no sender (Morris et al., 1995)	Sender present	64	0.17	−0.23
Ganzfeld	Edinburgh	Creativity (Dalton, 1997)	All	75	0.52	0.13
Ganzfeld	Edinburgh	Drumming (Symmons & Morris, 1997)	7 Hz drumming	25	0.54	0.03
Ganzfeld	Northampton	REG receiver/human receiver (Roe et al., 2003)	Human receiver	40	0.28	−0.17
Ganzfeld	Edinburgh	Creativity (Morris et al., 2003)	All	40	0.19	0.08
Precognitive remote viewing	York	—	—	99	0.42	−0.12
		All Trials		343	0.37	−0.04

Note: The effect size (*es*) was calculated as $Z/\sqrt{N}$, where Z was calculated using the sum-of-ranks method (Solfvin et al., 1978). $r_s(ap, es)$ shows Spearman's rank correlation between the trials' effect sizes and the global 3-hourly GMA index *ap*.

effect size ($Z/\sqrt{N}$) greater than an arbitrary threshold of 0.15 were included. The included trials are listed in Table 1, which also shows the correlation between ESP effect size and the global 3-hourly GMA index, *ap*. None of these correlations is significant by a 2-tailed test.

Ganzfeld Trials

The ganzfeld trials were conducted at the University of Edinburgh and the University of Northampton. In each trial, one participant acted as a sender who attempted to psychically transmit information about a film clip to a second participant, the receiver. The receiver sat in a separate room and, following a relaxation period, was immersed in white noise (played through headphones) and red light, typically for half an hour, during which time he would verbalize any impressions received. Following this *visualization period*, the receiver was played the target clip and three decoy clips in a random sequence, and rated each clip according to its similarity to his impressions. Each trial was then assigned a rank score from 1 (the best match) to 4.

Some aspects of the procedure were peculiar to the location or study. At the University of Edinburgh, the receiver's room was constructed from a faraday cage. Several large holes had, however, been cut into this cage, severely reducing its effectiveness as an electromagnetic shield. In any case, a faraday cage will not shield against the low-frequency magnetic fluctuations that are the subject of this investigation (Schmitt, 2002: 196). In the 7 Hz drumming condition of the Drumming study (see Table 1), the receiver was played drumming at a frequency of 7 Hz during the visualization period.

Precognitive Remote Viewing Trials

The remote viewing trials, details of which have not hitherto been published, were conducted at the Museum of Psychic Experience in York. In each trial, between 2 and 14 visitors to the museum acted as "remote viewers". The viewers were guided through a relaxation exercise by a member of the museum staff and then, in the *visualization period*, they were asked to visualize a photograph that they would later be shown, and to draw their impressions. A separate member of the museum staff acted as a judge, who collected the drawings and then randomly selected one of 50 sets of four photographs. The judge compared each viewer's drawing to the four photographs and assigned a rank score of 1 to the most similar, 2 to the next most similar, and so on. The judge then randomly selected a target photograph from the set of four and placed this in a room where, within 2 hours, it would be presented to the viewers. An overall rank score for the trial was determined by comparing the mean rank assigned to the target photograph with the mean rank assigned to each of the three decoys. The series of 104 trials (99 of which are included in this analysis – five were excluded due to missing data) was highly successful, yielding a Z score of 4.34, $p = 0.0000071$.

Data Preparation

The score for each ESP trial was converted into an effect size using the formula:

$$es = \frac{r_{MCE} - r_{OBS}}{\sqrt{(N^2 - 1)/12}} + adj$$

where r_{MCE} is the mean rank expected by chance, r_{OBS} is the observed rank and adj is an adjustment such that the effect size for each condition matches the overall mean effect size of all included trials. The effect sizes were adjusted in this way to eliminate the possibility of artifacts arising in the analysis, for example due to the coincidence of a high-scoring ESP condition with a period of low or high GMA.

The approximate LST of the start of each trial's visualization period was calculated using the formula:

$$h_{LST} \equiv h_{UT} + 0.0657d - \frac{L}{15} - 17.4 (\mathrm{mod}\ 24)$$

where h_{LST} is hours LST, h_{UT} is hours Universal Time, d is the day of the year and L is degrees west longitude.

Geomagnetic Field Measurements

I used geomagnetic field measurements from the SAMNET array of magnetometers in Northern Europe, which began operation on October 1,

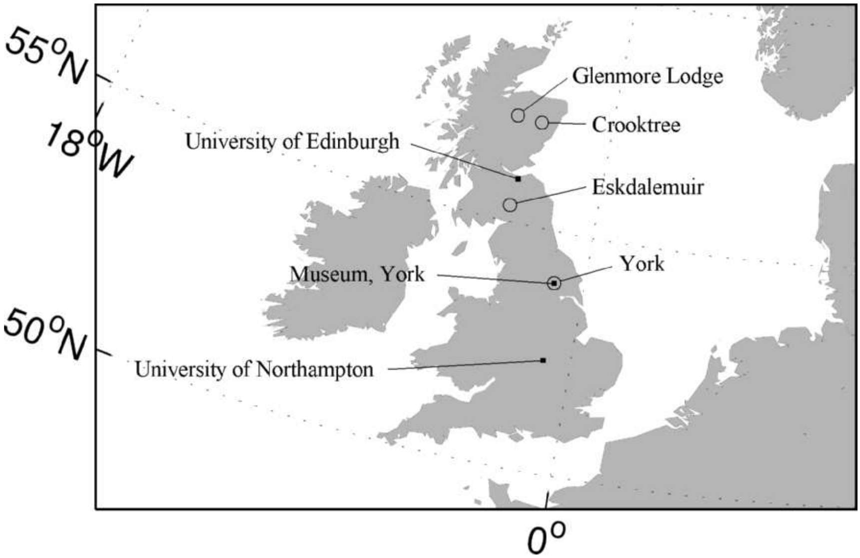


Fig. 1. Magnetometer locations (circles) and ESP trial locations (squares).

1987. Figure 1 shows the locations of the magnetometers used. I selected measurements from the nearest operating magnetometer at the time of each ESP trial; the mean distance between magnetometer and ESP trial location was 126 km (minimum 2 km, maximum 261 km). For the first 8 years of operation, the magnetometers sampled the Earth's field every 5 seconds; then in mid-November 1995 the sampling interval increased to 1 second. Each magnetometer recorded the field intensity in two horizontal directions, magnetic north and magnetic east, and in some cases vertically downwards. As the record of vertical measurements is patchy, this study uses only horizontal measurements, as is consistent with the method used to derive the global GMA indices. The resolution of the measurements is 0.1 nT.

The Analysis Period

I chose a *period of interest* as a 2-hour duration beginning half an hour before the visualization period of each ESP trial. This period covers the whole of the visualization and judging periods for almost all of the trials. The *analysis period* was then defined as starting 20 minutes before and ending 20 minutes after this period of interest. These extra 20-minute segments were added because the start and end of the extracted data would be tapered, as described later. The field measurements in each analysis period were manually inspected and the few periods containing bad data, for example due to interference from man-made sources, were discarded.

TABLE 2
Frequency Bands Used in the Analysis

Band	Period (seconds)		Corresponding standard classification	
	From	To	Continuous (regular sinusoidal)	Irregular
1	2	5	Pc1 (0.2–5 s)	Pi1 (1–40 s)
2	5	10	Pc2 (5–10 s)	Pi1 (1–40 s)
3	10	40	Pc3 (10–45 s)	Pi1 (1–40 s)
4	40	150	Pc4 (45–150 s)	Pi2 (40–150 s)
5	150	600	Pc5 (150–600 s)	

Data Transformation

The field measurements in each analysis period were transformed into the frequency domain by applying a fast Fourier transform (FFT)[1]. To minimize the introduction of artifacts during this process, the data were de-trended and pre-processed with a Tukey (split cosine bell) window (Bloomfield, 1976: 85) with 25% of the data tapered. Power was summed within each of five frequency bands, the boundary points of which were chosen to correspond closely to the standard geomagnetic pulsation categories, as shown in Table 2. Finally, for each band, the larger of the north and east power was selected (consistent with the method for deriving geomagnetic indices).

Data Cleaning

In line with the general recommendation when analyzing time-series data (Chatfield, 2004: 13), the record of geomagnetic field measurements between the first and last ESP trial was examined for any trends or discontinuities that might be indicative of errors. This was achieved by extracting a 160-minute segment of measurements starting at 14:25 UT for each day within this period, transforming into the frequency domain (as described above) and then plotting the power in each of bands 1 to 5 over time. Several discontinuities were discovered, which upon investigation were found to coincide with upgrades to the magnetometers. The magnetometers had been calibrated, but their sensitivity to fine variations, as revealed in the frequency spectrum, varied between equipment. In these cases the data were corrected using measurements taken at York from Jan 1, 2000 as a baseline. Where a correction was not possible, for example where no suitable alternative magnetometer was available for comparison, the data were discarded.

Geographic Extent of Geomagnetic Features

Table 3 shows Spearman's rank order correlations of power in each band (north direction only), firstly between York and Glenmore Lodge (a distance of

TABLE 3
Spearman's Rank Order Correlations of Power in Bands 1–5, between: (1) York and Glenmore Lodge; and (2) York and Eskdalemuir

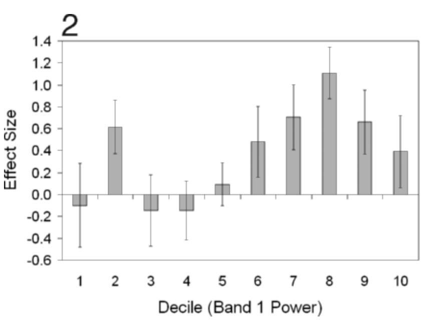
	Spearman's rank order correlation	
	York and Glenmore Lodge	York and Eskdalemuir
	Distance 394 km	Distance 206 km
	December 1, 1996–November 30, 1997	October 1, 2002–November 20, 2002
Band	$N = 162$	$N = 49$
1	0.29	0.37
2	0.25	0.04
3	0.79	0.97
4	0.96	0.99
5	0.98	0.99

394 km), and secondly between York and Eskdalemuir (distance 206 km). In both cases the correlations for bands 3, 4 and 5 are large, but the correlations for bands 1 and 2 are small, demonstrating that band 1 and 2 disturbances are highly localized. The band 1 and 2 data were therefore discarded for all but the 99 remote viewing trials conducted at the Museum of Psychic Experience in York, for which the magnetometer was also located in York.

Analysis

Analysis by Power in Band

(i) Bands 1 and 2. Figures 2 and 3 show bar charts of ESP effect size (with one standard error bars) by decile of power in bands 1 and 2. So for example, in Figure 2, the leftmost bar shows the ESP effect size for the 10% of trials with the



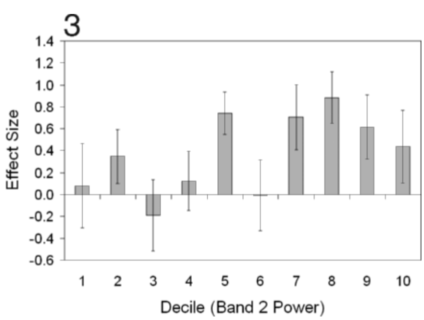


Fig. 2. ESP effect size by decile of band 1 power. Fig. 3. ESP effect size by decile of band 2 power.

TABLE 4
Spearman's Rank Order Correlation Matrix for Power in Bands 1 to 5

	Band				
Band	1	2	3	4	5
1	1.00	0.89[a]	0.26[a]	0.18[a]	0.05[a]
2		1.00	0.25[a]	0.18[a]	0.15[a]
3			1.00	0.68[b]	0.50[b]
4				1.00	0.69[b]
5					1.00

[a] $N = 99$.
[b] $N = 343$.

least disturbance in the band 1 frequency range, whereas the rightmost bar shows the effect size for the 10% of trials with the most pulsation activity in this band.

Figure 2 reveals a striking pattern: virtually all of the ESP effect is attributable to trials conducted during the top half of band 1 power. This pattern is also present to a lesser degree for band 2, but note that these patterns are not independent, because the power within each band is correlated with that of neighboring bands (see Table 4). Spearman's rank order correlation between ESP effect size and band 1 power is 0.28 ($p = 0.0059$, 2-tailed). However, as I will present an effect size bar chart for each of the five bands, in order to accurately gauge the true significance it is necessary to correct for these multiple analyses. To this end, I performed a Monte Carlo simulation, wherein for each of 10,000 runs, the ESP trial results were randomly redistributed and the correlation between ESP effect size and power in bands 1–5 recalculated. 250 runs resulted in a positive or negative rank order correlation for one or more of the bands that was *more unlikely* (assuming the null hypothesis) than the actual band 1 finding, thereby yielding a significance estimate of $p = 0.025$.

Figure 4 shows that the average level of band 1 activity trends upwards over the period of the 99 trials that make up the band 1 bar chart, and that the ESP effect size also increases over this period. The former is probably due to progression of the 11-year solar cycle, and the latter could perhaps be due to the museum staff becoming increasingly skilled at running the experiment. The shape of the chart in Figure 2 could therefore be an artifact arising from the coincidence of these two upward trends. To discriminate between the two possibilities, I re-plotted Figure 2, this time using de-trended ESP data (see Figure 5). If the pattern in Figure 2 was due entirely to the trends in the data, the pattern should disappear in Figure 5, but this is not the case: the same pattern is present, albeit to a lesser degree (the rank-order correlation of ESP scores with band 1 activity is now non-significant at 0.13). The artifact hypothesis would require both that the coincidence of trends in ESP scores and band 1 activity was due to chance, and that also the residual pattern in the de-trended data was due to

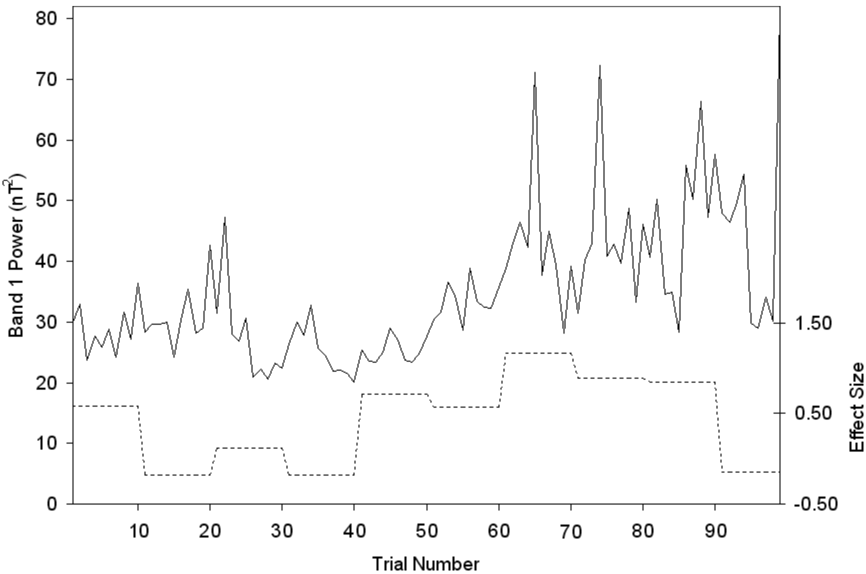


Fig. 4. Band 1 power (solid line, left axis) and ESP effect size in groups of 10 trials (dashed line, right axis).

chance. The alternative possibility is that the residual pattern is not due to chance, and that the trend of increasing ESP scores is due to the rising band 1 activity through the period of the experiment. The issue is not clear-cut, but it seems reasonable to provisionally reject the artifact hypothesis.

It is worth noting that although band 1 measurements were only available for

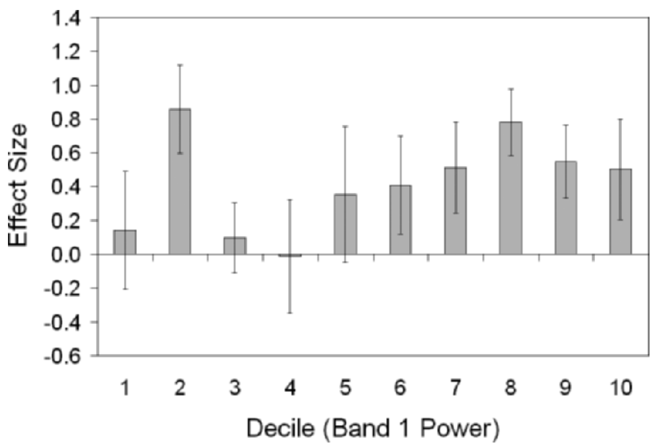


Fig. 5. ESP effect size by decile of band 1 power (ESP data de-trended).

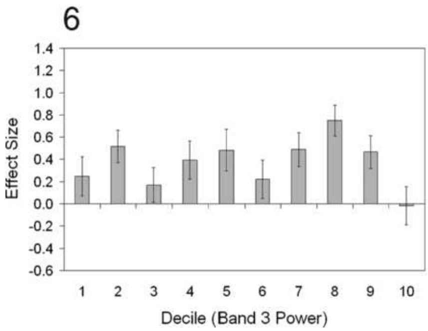


Fig. 6. ESP effect size by decile of band 3 power. Fig. 7. Distribution curve for band 3 power. A vertical line delineates the top decile.

99 trials, these trials were from the Museum of Psychic Experience's remote viewing experiment, which had an element of *redundancy* in that between 2 and 14 (average 9) viewers contributed to each trial and yet each trial's result was condensed into a single rank-score from 1 to 4. One would therefore expect results from this study to give a clearer representation of the relationship between environmental conditions and ESP effect.

(ii) Band 3. Figure 6 shows ESP effect size by decile of power in band 3. The chart shows that at the top decile of band 3 power, ESP effect size drops to zero. Note that due to the skewed distribution of band 3 power, the power for trials during this top decile is much greater than that for trials in lower deciles (Figure 7). Comparing ESP results of trials conducted during this top decile with those

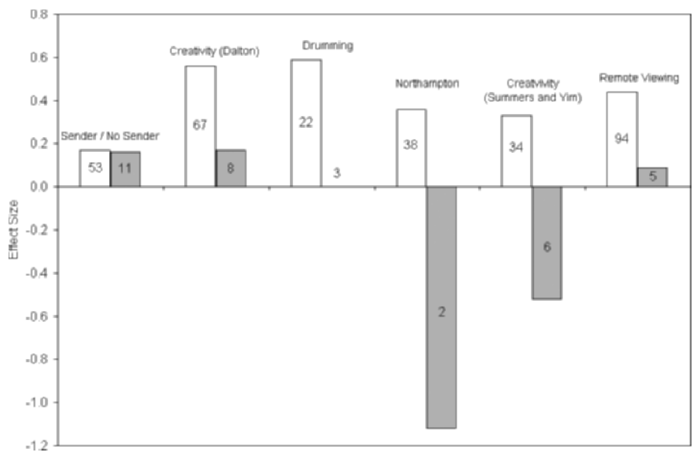
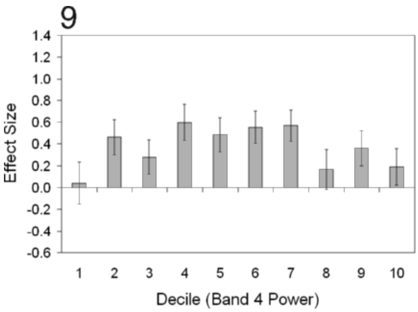


Fig. 8. ESP effect size for trials conducted during the top decile of band 3 activity (shaded bars) and during less disturbed periods (unshaded bars), for each study. The number of trials represented by each bar is shown.



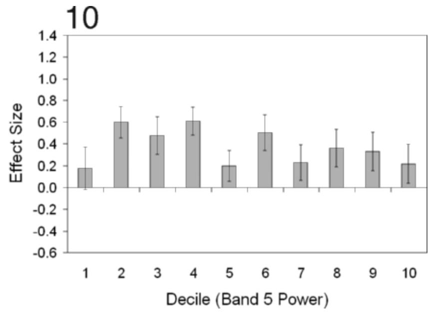
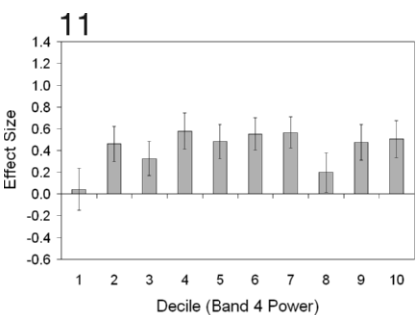


Fig. 9. ESP effect size by decile of band 4 power. Fig. 10. ESP effect size by decile of 5 band power.

conducted during lower deciles confirms a significant difference ($t = -2.52$, $p = 0.012$, 2-tailed). Assessment of the true significance, however, is problematic. If we limit the set of analyses that we may have performed to simple tests of correlation and then correct for multiple analysis, the result would clearly not be significant. On the other hand the pattern is remarkably homogeneous – the effect size for trials conducted during the top decile of band 3 activity is lower than the average effect size for trials conducted during less disturbed periods in all six studies (Figure 8).

(iii) Bands 4 and 5. Figures 9 and 10 show ESP effect size by decile of power in bands 4 and 5. These charts show that the relationship between ESP effect size and band 4 and 5 power forms an inverted-U-shape pattern. Figures 11 and 12 show the same charts, but this time with trials conducted during the top decile of band 3 power excluded. These figures demonstrate that the drop-off of ESP effect size towards the top of band 4 and 5 power is attributable to the pattern of ESP results by band 3 power.



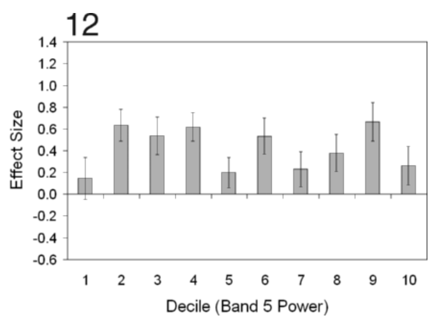


Fig. 11. ESP effect size by decile of band 4 power, excluding trials conducted during the top decile of band 3 power. Fig. 12. ESP effect size by decile of band 5 power, excluding trials conducted during the top decile of band 3 power.

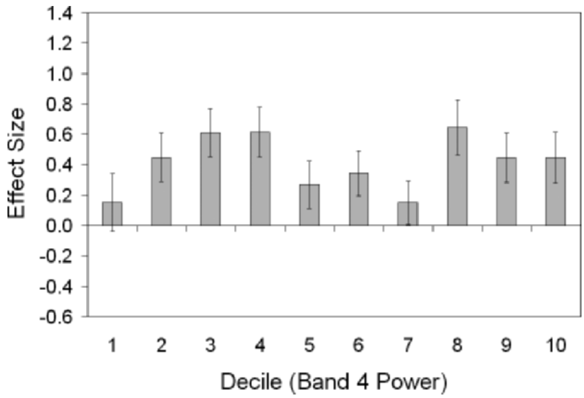


Fig. 13. ESP effect size by decile of band 4 power, for the 99 trials where band 1 data was available.

In a similar way, it can be shown that the low ESP effect size for trials conducted during the bottom decile of band 4 power (Figure 9) is probably attributable to the pattern of ESP results by band 1 power. Figure 13 shows ESP effect size by decile of power in band 4, for the 99 trials for which band 1 data is available. The effect size for the bottom decile of band 4 power is 0.15 – the equal lowest along with decile 7, so to some extent the pattern in Figure 9 is also present within this subset. Figures 14 and 15 show the same chart as Figure 13, but this time split between trials conducted during the bottom and top halves of band 1 power. If the reduction of ESP effect size in the lowest band 4 decile was an independent pattern, we would expect this pattern to be present in these figures. This is not the case, suggesting that the low ESP effect size for the leftmost bar in Figure 9 is attributable to pattern of ESP results by band 1 power.

(iv) Summary. In summary, ESP effect is present only for trials conducted

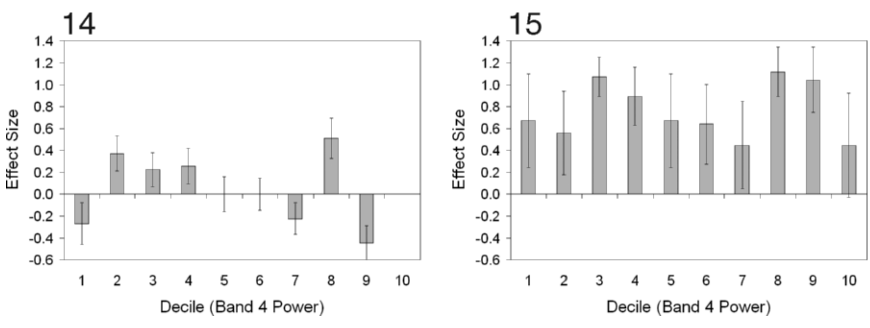


Fig. 14. ESP effect size by decile of band 4 power, for trials conducted during the bottom half of band 1 power. Fig. 15. ESP effect size by decile of band 4 power, for trials conducted during the top half of band 1 power.

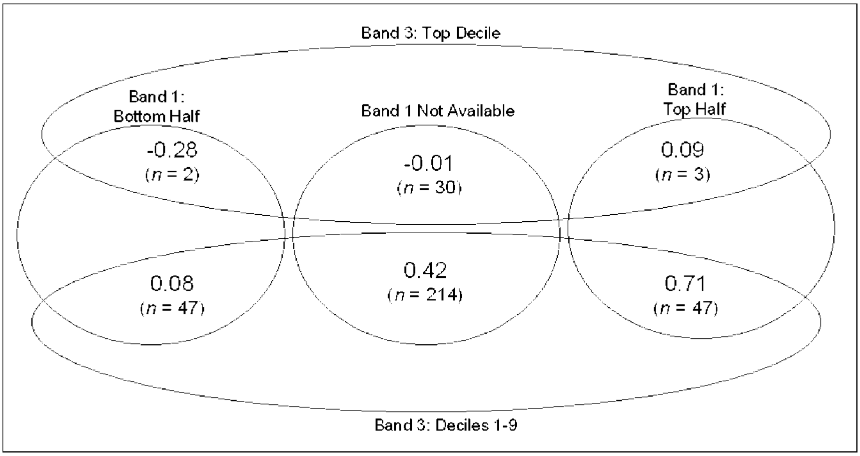


Fig. 16. Venn diagram illustrating ESP effect size as a function of power in bands 1 and 3.

during the top half of band 1 power, but absent for trials during the top decile of band 3 power. Figure 16 presents ESP effect size as a function of band 1 and 3 power, in order to illustrate the interaction of these two patterns. The diagram suggests that the reduction of ESP effect size during the most disturbed periods of band 3 activity takes precedence over the pattern of increased effect size with enhanced band 1 activity.

Analysis by Pulsation Character: Continuous / Irregular

The standard classification system (Jacobs, 1970) categorizes geomagnetic pulsations as either continuous (regular, sinusoidal pattern) or irregular. In accordance with this system, I visually examined the field measurements in each analysis period and recorded the proportion of the period that contained continuous pulsation activity. Spearman's rank order correlation between these proportions and the trials' effect sizes was 0.01 (n.s.). I also analyzed the data by comparing trials conducted during periods containing any pulsation activity (51 trials) with trials conducted during periods containing none (292 trials); a t-test of the trial effect sizes yielded $t = -0.31$ (n.s.). Therefore the *character* of the fluctuations does not appear to be related to ESP success.

LST

The question remains as to whether the pattern of ESP effect size by LST revealed in Spottiswoode's dataset (Spottiswoode, 1997b) appears in the present data. Two studies (Sender – No Sender, Creativity – Dalton) are in fact represented in both datasets, so the subsequent analysis is confined to new trials ($N = 204$). After Spottiswoode (1997b), I calculated the ESP effect size for a

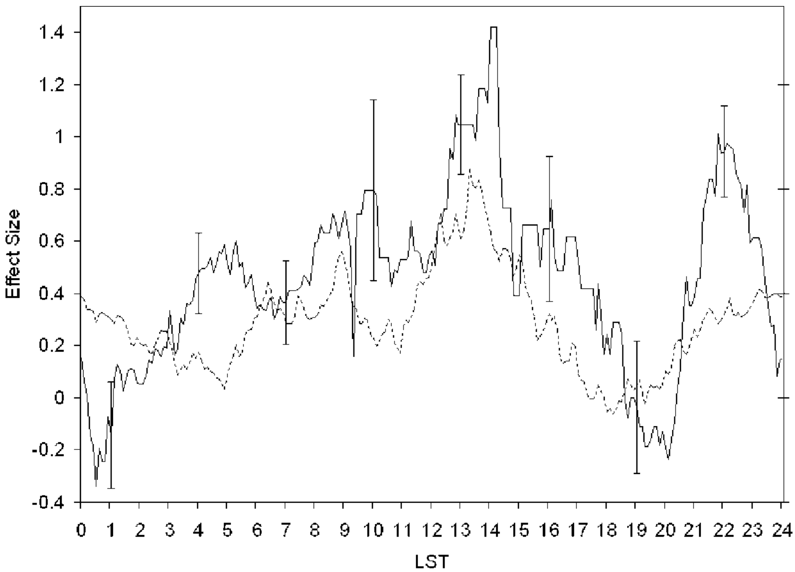


Fig. 17. ESP effect size as a function of LST, for 204 trials in the present study (solid line, left axis) and trials in Spottiswoode's dataset (dashed line, right axis), with one standard error bars.

2-hour window advanced in 0.1-hour increments through the LST day. The results are plotted as a solid line against the left axis in Figure 17, and the dashed line plotted against the right axis shows the equivalent effect sizes for Spottiswoode's database of 2,879 trials. The difference in average effect size is due to the different inclusion criteria for trials in each dataset. Calculation of Pearson's correlation between the points of the two graphs confirms what is clearly apparent: the graphs are well correlated ($r = 0.59$). Calculation of a p-value is not possible in this situation (at least not by customary methods) due to auto-correlations in both datasets arising from the windowing method. Note that most of the trials were conducted before 8:00 LST (Figure 18). There are many fewer trials at the times of the interesting features in Figure 17, i.e., the maximum of effect size around 14:00 and the minimum around 20:00; indeed the peak at 14:00 comprises just one data point. An alternative approach that gives equal weight to each trial is to calculate the correlation between each trial's effect size and the effect size on Spottiswoode's graph at that trial's LST. Using this method the correlation is significant: $r = 0.17$, $p = 0.007$, 1-tailed. These results support Spottiswoode's finding, and also provide the opportunity to examine whether the observed relationships between pulsation activity and ESP results can account for the pattern of ESP results by LST.

So the following analysis assesses whether pulsation activity can explain the distribution of ESP effect across LST. Contrary to what one would expect, the LST graph for those trials that *are* part of Spottiswoode's database is *not*

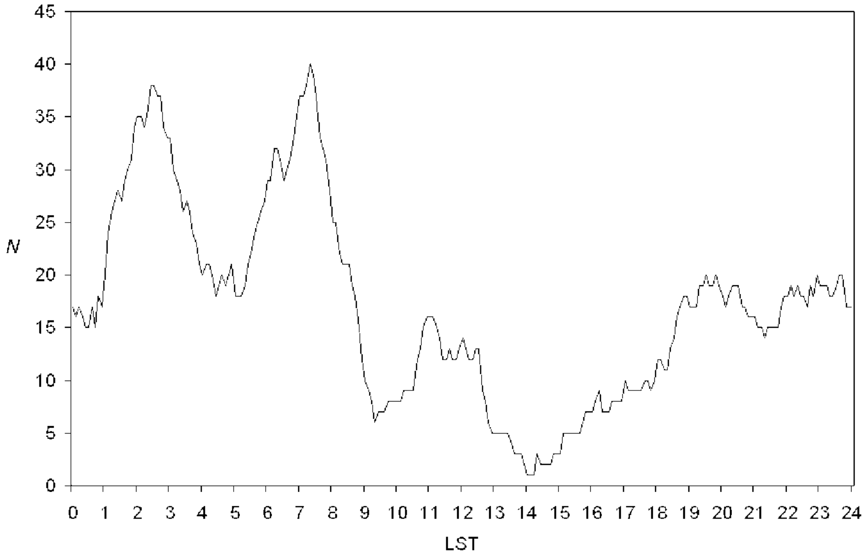


Fig. 18. Distribution of trials by LST. *N* is the number of trials in each 2-hour LST window.

correlated with Spottiswoode's graph ($r = -0.19$), therefore this analysis also uses only new trials ($N = 204$). For this analysis, I constructed a model to show what the result of each trial would have been if band 1 and 3 activity had been the only influencing factors. In this model, the effect size for each trial was replaced with the effect size from the appropriate region in the Venn diagram illustrated in Figure 19, then the trial effect sizes predicted by the model and the effect sizes on Spottiswoode's graph at each trial's LST were compared. The correlation was significant ($r = 0.18$, $p = 0.0049$), and the graph of the model's results by LST is a similar shape to Spottiswoode's graph (Figure 20), thus confirming that the similarity of the graph of ESP results by LST with Spottiswoode's graph is, at least in part, attributable to the pattern of ESP results by pulsation activity.

The relative contribution of each band in this explanation was assessed by creating two further, similar, models, the first of which represents only the observed band 1 pattern, and the second, only the observed band 3 pattern. To allow a valid comparison these models were constructed from the 99 trials for which data were available for both bands 1 and 3 (the LST graph for this subset of trials was also correlated with Spottiswoode's: $r = 0.57$; and by the trial-by-trial method, $r = 0.20$, $p = 0.023$). The results for the models representing the band 1 pattern only, and the band 3 pattern only, were respectively $r = 0.28$, $p = 0.0028$ and $r = 0.02$, n.s., suggesting that the correlation of the original model's

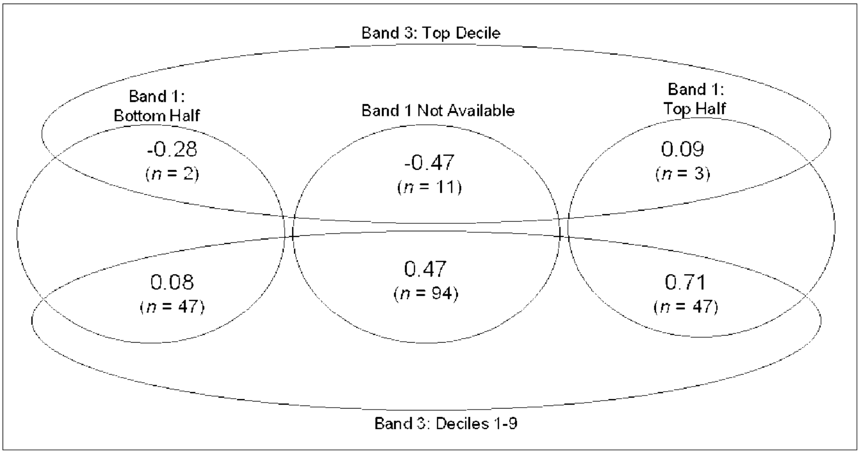


Fig. 19. Venn diagram illustrating ESP effect size as a function of power in bands 1 and 3, for 204 trials not included in Spottiswoode's dataset.

results with the effect sizes on Spottiswoode's graph is due entirely to the pattern of ESP results by band 1 activity.

Piecing Together the Jigsaw

If the patterns revealed by the foregoing analyses represent real underlying relationships, then we may be in possession of two more pieces of the jigsaw puzzle: ESP is present only during periods of enhanced band 1 pulsation activity; and ESP is absent during periods with strong band 3 pulsations. The predominant pattern is the positive correlation of band 1 activity with ESP effect – but this would appear to contradict the literature, which suggests, generally, an inverse relationship between ESP and GMA. The problem is resolved by examination of the relationship between band 1 and 3 activity and the global GMA index *ap* (Figures 21 and 22): there is a clear correlation between band 3 activity and *ap*, but the same is not true for band 1. So let us consider the findings of previous studies and assess the fit with the band 1 and 3 patterns:

1) The correlation of ap with ESP effect size is, overall, slightly negative. When individual studies find a stronger correlation, it is most often negative, but occasionally positive.

The predominant pattern of ESP success during periods of enhanced band 1 activity would not result in a correlation between *ap* and ESP effect size; but one would expect, overall, a small negative correlation due to the reduction in ESP effect at the top end of band 3 activity. A larger negative correlation would be expected for studies conducted during periods of enhanced GMA (e.g., at equinoxes, or at peak periods of GMA during the 11-year solar cycle), as large band 3 pulsations would be more prevalent at these times. Occasionally band 1

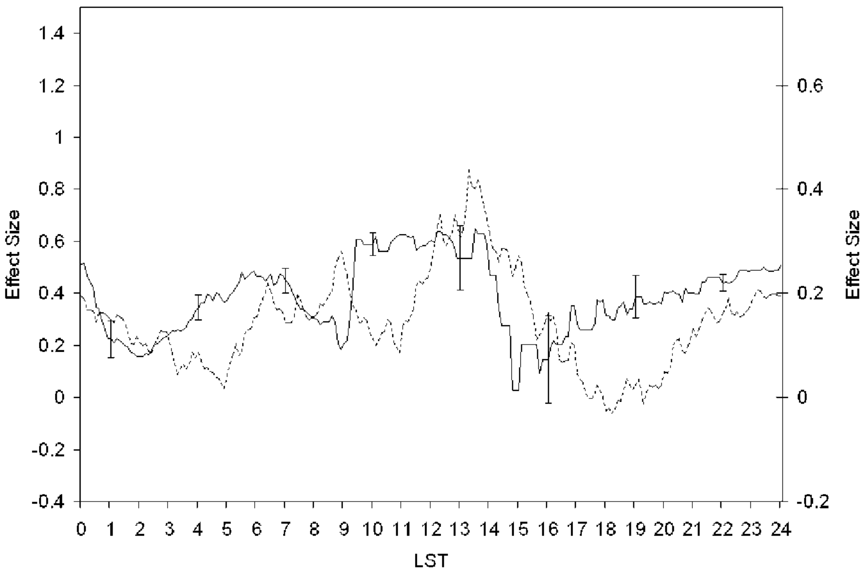


Fig. 20. Effect size by LST, for model of ESP based on band 1 & 3 activity (solid line, left axis) and trials in Spottiswoode's dataset (dashed line, right axis), with one standard error bars.

activity *is* correlated with *ap*, which may explain the occasional positive correlations between *ap* and ESP effect size. For example, at York, during 160-minute periods commencing 9:10 UT, 12:10 UT and 15:10 UT each day throughout the geomagnetically disturbed year 2003, band 1 pulsation activity was significantly correlated with *ap* ($r_s = 0.14$, $p = 0.000006$, 2-tailed).

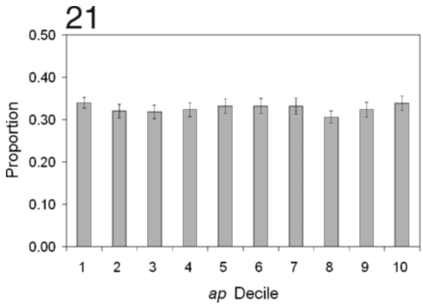
2) There is a peak of ESP effect at 13:20 LST and a minimum of effect at 18:20 LST.

We have seen that the pattern of ESP results by LST for the present study is similar to the pattern of results in Spottiswoode's graph, and that for the present study this pattern is, at least in part, attributable to band 1 pulsation activity.

3) ESP effect size and ap are strongly and negatively correlated at 12:55 LST, close to the point of maximum ESP effect size.

At times of day / times of year when band 1 pulsations are prevalent (and thus ESP effect size is high), one would expect a larger difference between effect sizes for periods with and without large band 3 pulsations, and for this to be reflected in a larger negative correlation between *ap* and effect size. The Venn diagram (Figure 16) illustrates: during periods of high band 1 activity, the effect size when band 3 is low is 0.71, whereas when band 3 is high the effect size is 0.09.

The findings of the present study, therefore, fit excellently with the patterns previously reported.



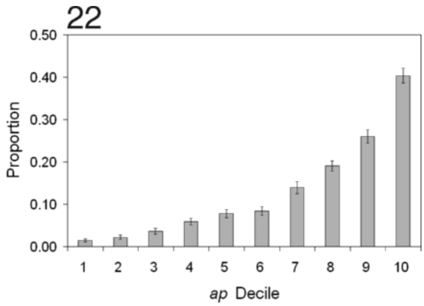


Fig. 21. Proportion of periods with enhanced (top-half) band 1 activity, by *ap* decile, for 160-minute periods commencing 9:10 UT, 12:10 UT and 15:10 UT each day between Nov 4, 1996 and Mar 19, 2005, with one standard error bars. Fig. 22. Proportion of periods with enhanced (top-decile) band 3 activity, by *ap* decile, for 160-minute periods commencing 9:10 UT, 12:10 UT and 15:10 UT each day between Nov 4, 1996 and Mar 19, 2005, with one standard error bars.

Discussion

The analyses presented here utilize, for the first time, local 1-second geomagnetic field measurements to test for a link between pulsation activity and the results of ESP experiments. In the studies examined, two patterns were observed: ESP was found to be present only during periods of enhanced band 1 activity, and not present at all during the most disturbed periods of band 3 activity. The band 1 analysis was, however, handicapped by the small number of trials for which pulsation activity data was available, and interpretation was made more difficult by trends present in both ESP and geomagnetic data; therefore these observations should be treated with caution. Nevertheless, in the trials examined the pattern of ESP effect by LST was similar to that found by Spottiswoode, and this pattern was found to be attributable to the pattern of ESP results by band 1 activity. The observed patterns were also demonstrated to have excellent explanatory power in terms of accounting for findings previously reported in the literature.

How can these findings be confirmed? Firstly, let's consider the band 3 pattern. As band 3 disturbances cover a relatively wide geographical area, it may be possible to identify further trials that can be checked. The present analysis most probably covers all of the good quality trials (i.e., those from a study-condition with an effect size >0.15) from the U.K., but there may be suitable trials from other countries that are within the vicinity of a sufficiently sensitive magnetometer. Alternatively, one could examine study-conditions that were omitted from this analysis because their effect size fell below the inclusion threshold. In this case, a positive result would support the hypothesis, but a negative result would be ambiguous – it could indicate either that the hypothesized pattern is not present, or that there is no ESP effect within the dataset. The remaining possibility is to wait until new trials are available from U.K. universities.

This study was fortunate to have data available from the long and highly successful series of remote viewing trials conducted at the Museum of Psychic Experience in York, for which the nearest magnetometer was also located in York. This enabled the relationship between the higher-frequency disturbances (bands 1 and 2) and ESP to be studied. Unfortunately, both the Museum of Psychic Experience and the SAMNET observatory at York have now closed, so there is no opportunity to verify these findings using the same data sources. The way forward, therefore, would be to have measuring equipment of sufficient sensitivity and sampling interval installed at a university that is studying ESP.

It should be noted that in the present study, the top end of the geomagnetic frequency range could not be studied at all due to limitations in both the temporal and amplitude resolution of the measuring equipment. Almost certainly, geomagnetic pulsations near the upper bound of measured frequencies (0.5 Hz) will be correlated with activity immediately above this range; so there is the possibility that the band 1 pattern is in fact due to this higher frequency activity.

One must also consider the possibility that GMA is an indirect variable, which is correlated with another environmental factor that is actually responsible for the effect. For example, ELF spherics (the standing waves surrounding the Earth, continuously powered by lightning strikes) in the 5–50 Hz frequency range, are known to be disrupted by GMA. However, the size of the observed correlations and the specificity of frequencies argue against an indirect effect.

Theoretical Implications

Figure 23 is presented in order to move from the somewhat abstract terms ‘‘band 1’’ and ‘‘band 3’’ to a more concrete, visual representation of these disturbances. The figure shows how a typical band 1 and band 3 disturbance would look on the scope of a magnetometer. The *y*-axis shows the deviation of geomagnetic field from an arbitrary baseline, in nT. 1 nT is about 1/60,000th of the total intensity of the Earth’s field, so these fluctuations are really quite small. The *x*-axis shows time, and one can see that the pulsations are very slow: the period between peaks of a band 3 pulsation ranges between 10 and 40 seconds.

Looking back at Figure 2 we can see that the ESP effect is as good as absent in the least disturbed half of band 1 activity. This suggests that this frequency of pulsation may be a necessary condition for ESP. Assuming that geomagnetic pulsations are acting directly on the ESP system, the question arises: by what mechanism?

One possibility is that the pulsations act directly on the brain, perhaps by stimulating areas associated with the perception of extrasensory information, so that perception is ‘‘switched-on’’ when band 1 pulsations are present, but ‘‘overloaded’’ during periods of intense band 3 pulsations. An objection is often raised that fluctuations in the geomagnetic field are too small for the brain to detect, and that these would be swamped by much stronger man-made signals.

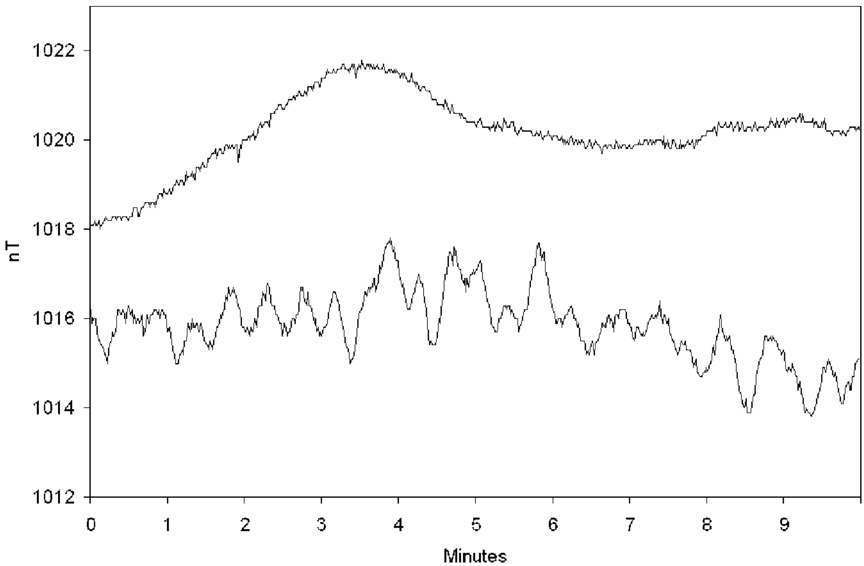


Fig. 23. Typical band 1 (top) and band 3 (bottom) pulsation activity associated with ESP success and failure respectively. The *y*-axis shows the deviation of geomagnetic field from an arbitrary baseline.

The brain does, however, contain magnetically sensitive material (Kirschvink et al., 1992), and it is conceivable that the brain has evolved sensitivity to the particular frequencies of natural disturbances. There is also some laboratory evidence, albeit scant (e.g., Subrahmanyam et al., 1985), that geomagnetic pulsations can affect brain function.

Recall that the trials from which Figure 2 is constructed are precognitive trials, that is, they represent information passing from a future event backwards in time to the present. Of course, real-time ESP can usually also be accounted for by the flow of information backwards in time, that is, from the future event where the participant views the target, back to the time of the trial. The laws of physics do permit the passage of information backwards in time, via the mechanism of closed timelike curves in spacetime (Earman & Wüthrich, 2006), and indeed in the Gödel spacetime model (Radu et al., 2002), a closed timelike curve passes through every point within the universe. So perhaps the band 1 and 3 magnetic fluctuations act to modify the shape of these structures, thus modulating the flow of information. Alternatively, perhaps the fluctuations modulate the interface between the information flows and consciousness, akin to a ‘‘focussing’’ effect.

Practical Implications

In the presence of band 1 and the absence of band 3 pulsations, the remote viewing study achieved an effect size of 0.75 (unadjusted), close to the effect size of 0.71 that Spottiswoode (1997b) reports for optimum LST and GMA conditions. This suggests the possibility that, subject to confirmation of the patterns, the reliability of these types of experiments could be significantly increased either by conducting trials during optimum conditions, or, if this is not practicable, pre-arranging to disqualify trials that are subsequently found to have been conducted during sub-optimal conditions. Looked at another way, we could say that if it is true that band 1 pulsations are a necessary condition for ESP, then, according to Figure 21, only approximately 1 in 3 ESP trials conducted between November 1996 and March 2005 would have had any chance of success – and this is without accounting for the band 3 pattern.

The final practical consequence of this work is that it may allow for the construction of a device that synthesizes the optimum conditions for ESP. The only ‘‘leap'' required would be to suppose that a locally created fluctuating magnetic field would have the same effect as the large-scale magnetic disturbances of the natural environment.

To generate a uniform, fluctuating, magnetic field that envelopes a participant would require the construction of a ‘‘Helmholtz chamber''. Such chambers comprise two or three large wire coils that surround the participant. These chambers are often used to study the effects of magnetic fields upon humans, and indeed Spottiswoode (1993) has already attempted to use such a device to influence ESP performance, but of course at the time he did not have detailed information about the specific frequencies that might be effective. Researchers should note that the orientation of the participant in the field may be important (Subrahmanyam et al., 1985).

Perhaps an irregularly shaped fluctuating field would suffice, in which case, a set of smaller coils situated around the participant's head may be adequate. Such a device would be similar to the helmet used at Persinger's laboratory to induce in participants the sensed presence of a sentient being (St.-Pierre & Persinger, 2006).

Conclusion

The analysis of geomagnetic pulsation activity in relation to ESP success was initially conceived as a first step in a process of elimination in the search for an explanation for the reported associations between GMA and LST with ESP. Rather than eliminating the possibility, this factor emerges as a leading candidate for a solution to the problem.

Acknowledgments

The author extends thanks to the University of Edinburgh, the University of Northampton and the Museum of Psychic Experience for kindly supplying data from ESP experiments and to SAMNET for supplying magnetometer data. SAMNET is a PPARC National Facility operated by Lancaster University. Thanks also to Mr. James Spottiswoode, Mr. Alex Sabell, Dr. Ciarán O'Keeffe and Dr. Alex Hallums for their valuable comments on the drafts.

References

Adams, M. H. (1986). Persistent temporal relationship of ganzfeld results to geomagnetic activity, appropriateness of using standard geomagnetic indices. *Proceedings of Presented Papers: The 29th Annual Convention of the Parapsychological Association* (pp. 471–485).

Bloomfield, P. (1976). *Fourier Analysis of Time Series: An Introduction.* John Wiley & Sons.

Booth, J. N., Charette, J. C., & Persinger, M. A. (2002). Rankings of stimuli that evoked memories in significant others after exposure to circumcerebral magnetic fields: Correlations with ambient magnetic activity. *Perceptual and Motor Skills, 95,* 555–558.

Campbell, W. H. (2003). *Introduction to Geomagnetic Fields* (2nd ed.). Cambridge University Press.

Chatfield, C. (2004). *The Analysis of Time Series: An Introduction* (6th ed.) CRC Press.

Dalton, K. (1997). Exploring the links: Creativity and psi in the ganzfeld. *Proceedings of Presented Papers: The 40th Annual Convention of the Parapsychological Association* (pp. 119–134).

Earman, J., & Wüthrich, C. (2006). Time machines. *The Stanford Encyclopedia of Philosophy* (Spring 2006 Ed.). Available at: http://plato.stanford.edu/archives/spr2006/entries/time-machine/.

Jacobs, J. A. (1970). *Geomagnetic Micropulsations.* Springer-Verlag.

Kirschvink, J. L., Kobayashi-Kirschvink, A., & Woodford, B. J. (1992). Magnetite biomineralization in the human brain. *Proceedings of the National Academy of Sciences, 89,* 7683–7687.

Krippner, S., & Persinger, M. (1996). Evidence for enhanced congruence between dreams and distant target material during periods of decreased geomagnetic activity. *Journal of Scientific Exploration, 10,* 487–493.

Makarec, K., & Persinger, M. A. (1987). Geophysical variables and behavior: XLIII. Negative correlation between accuracy of card-guessing and geomagnetic activity: A case study. *Perceptual and Motor Skills, 65,* 105–106.

Morris, R., Summers, J., & Yim, S. (2003). Evidence of anomalous information transfer with a creative population. *Proceedings of Presented Papers: The 38th Annual Convention of the Parapsychological Association* (pp. 244–259).

Morris, R. L., Dalton, K., Delanoy, D. L., & Watt, C. (1995). Comparison of the sender / no sender condition in the ganzfeld. *Proceedings of Presented Papers: The 46th Annual Convention of the Parapsychological Association* (pp. 116–131).

Nelson, R. D., & Dunne, B. (1986). Attempted correlation of engineering anomalies with global geomagnetic activity. *Research in Parapsychology 1986* (pp. 82–85).

Persinger, M. A. (1989). Psi phenomena and temporal lobe activity: The geomagnetic factor. *Research in Parapsychology 1988* (pp. 121–156).

Persinger, M. A., Cook, C. M., & Tiller, S. G. (2002). Enhancement of images of possible memories of others during exposure to circumcerebral magnetic fields: Correlations with ambient geomagnetic activity. *Perceptual and Motor Skills, 95,* 531–543.

Persinger, M. A., & Krippner, S. (1989). Dream ESP experiments and geomagnetic activity. *Journal of the American Society for Psychical Research, 83,* 101–116.

Radin, D. I. (1994). Geomagnetism and psi in the ganzfeld. *Journal of the Society for Psychical Research, 59,* 352–363.

Radu, E., Astefanesei, D., & Dolgov, A. (2002). Quantum effects in a rotating spacetime. *International Journal of Modern Physics D, 11,* 715–731.

Roe, C. A., Holt, N. J., & Simmonds, C. A. (2003). Considering the sender as a PK agent in ganzfeld ESP trials. *Journal of Parapsychology, 67,* 129–145.

Schmitt, R. (2002). *Electromagnetics Explained: A Handbook for Wireless/RF, EMC, and High-speed Electronics.* Elsevier.

Solfvin, G. F., Kelly, E. F., & Burdick, D. S. (1978). Some new methods of analysis for preferential-ranking data. *Journal of the American Society for Psychical Research, 72,* 93–109.

Spottiswoode, S. J. P. (1990). Geomagnetic activity and anomalous cognition: A preliminary report of new evidence. *Subtle Energies, 1,* 65–77.

Spottiswoode, S. J. P. (1993). Effect of ambient magnetic field fluctuations on performance in a free response anomalous cognition task: A pilot study. *Proceedings of Presented Papers: The 36th Annual Convention of the Parapsychological Association* (pp. 143–156).

Spottiswoode, S. J. P. (1997a). Apparent association between effect size in free response anomalous cognition experiments and local sidereal time. *Journal of Scientific Exploration, 11,* 109–122.

Spottiswoode, S. J. P. (1997b). Geomagnetic fluctuations and free-response anomalous cognition: A new understanding. *Journal of Parapsychology, 61,* 3–12.

St.-Pierre, L. S., & Persinger, M. A. (2006). Experimental facilitation of the sensed presence is predicted by the specific patterns of the applied magnetic fields, not by suggestibility: Re-analyses of 19 experiments. *International Journal of Neuroscience, 116,* 1079–1096.

Sturrock, P. A., & Spottiswoode, S. J. P. (2007). Time-series spectrum analysis of performance in free response anomalous cognition experiments. *Journal of Scientific Exploration, 21,* 47–66.

Subrahmanyam, S., Sanker Narayan, P. V., & Srinivasan T. M. (1985). Effect of magnetic micropulsations on the biological systems – A bioenvironmental study. *International Journal of Biometeorology, 29,* 293–305.

Symmons, C., & Morris, R. L. (1997). Drumming at seven Hz and automated ganzfeld performance. *Proceedings of Presented Papers: The 40th Annual Convention of the Parapsychological Association* (pp. 441–453).

Wilkinson, H. P., & Gauld, A. (1993). Geomagnetism and anomalous experience, 1868–1980. *Proceedings of the Society for Psychical Research, 57,* 275–310.

Note

[1] The FFT transformation was performed with a version (v1.9.5.1) of Sigview32 specially customized for this study to support the Tukey window pre-process. The transformation process was controlled using Macro Scheduler v7.4.009. All data transformation and data cleaning steps were performed blind of the ESP trial results. All transformation, data cleaning and analysis steps were performed twice, in order to verify that no errors were introduced during the process.